Measurement of spectra in “water window” wavelength region

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INTRODUCTION

We demonstrate spectra measurement of nitrogen, argon and carbon dioxide as a possible source of XUV radiation in “water window” (2.2 - 4.4 nm) region. The other goal is to find the best conditions for maximum output energy per steradian for each of these three gases. From our earlier experiments we expect strong emission at these wavelengths: 2.88 nm in nitrogen N VI, $1s^2$ - 1s2p, in argon 3.82 nm Ar X, $2s^22p^5$- $2s^22p^43d$ and 3.83 nm Ar XI, $2s^22p^4$ - $2s^22p^33s$, carbon dioxide 3.34 nm C V, $1s^2$ - 1s4p, 3.37 nm C VI, 1s - 2p and 4.03 nm C V, $1s^2$ - 1s2p

EXPERIMENTAL SETUP

On Figure 1 is experimental setup of the experiment.Capillary discharge system with 10 cm long, 3.2 mm inner diameter alumina capillary and peak current amplitude pulse of 21 kA was used. Our spectroscopic system has a resoulution 0.03 nm and is composed from a silicon nitride free-standing transmission diffraction grating with 100 nm period and Reflex BI - CCD camera with frame size 512x512 pixels. Eight differrent pressures for each gas were measured to find best conditions for maximum output energy per steradian.

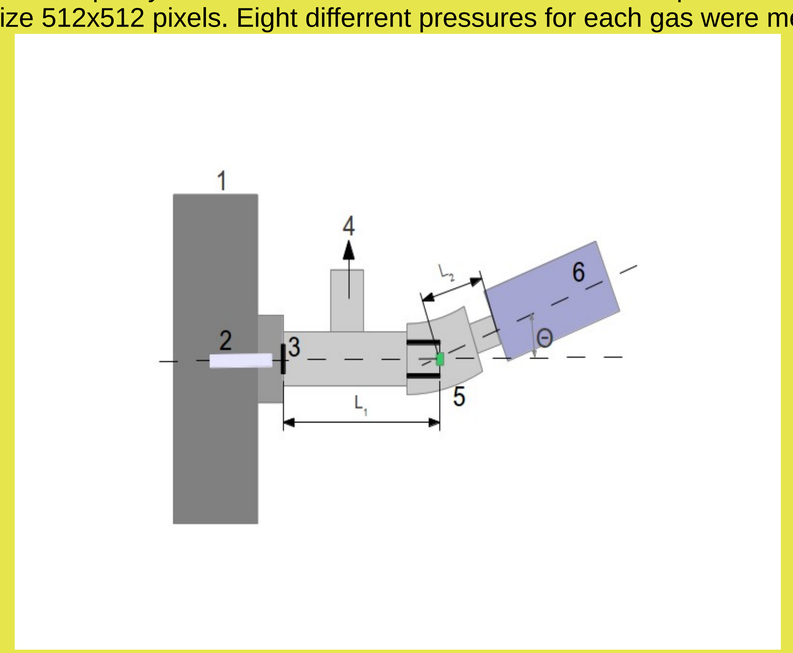

Figure 1 Schematic of aparature to measure gas spectra.

Fig. 1 Schematic of aparature

1. XUV source of radiation
2. Capillary
3. Inpur aperture
4. To the pump
5. Diffraction grating with output aperture
6. CCD camera

As XUV source was used capillary discharge pinching system with 10 cm long, 3 mm in diameter allumina capillary with peak current amplitude approximately 21 kA. More information about source can be found in Ref. 1.

BASIC INFORMATION ABOUT SPECTROMETER

Our spectroscopic system consists from diffraction grating placed in a special holder and BI-CCD camera RIGAKU. Diffraction grating is made from silicon nitride with period 100 nm and output aperture 80 microns. Input aperture of the system was 75 microns. CCD camera has resolution 512x512 pixels. Diffraction grating is placed 80 cm far from input aperture, distance from grating to CCD was 55 cm. We reached resolution 0.03 nm.
Spectra were recorded with and without titanium filter after ten shots exposure. Measurement with carbon plasma can be found in Ref. 2.

RESULTS

On figures 2 – 4 are spectra of nitrogen, argon and carbon dioxide without titanium filter. On figures 5 and 6 are spectra of nitrogen and argon behind titanium filter.

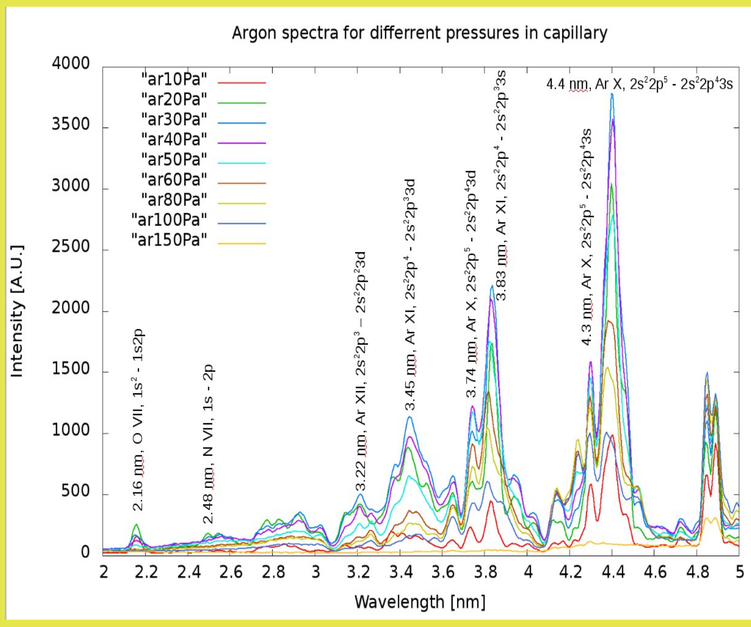

Figure 2 Argon spectra without Ti filter

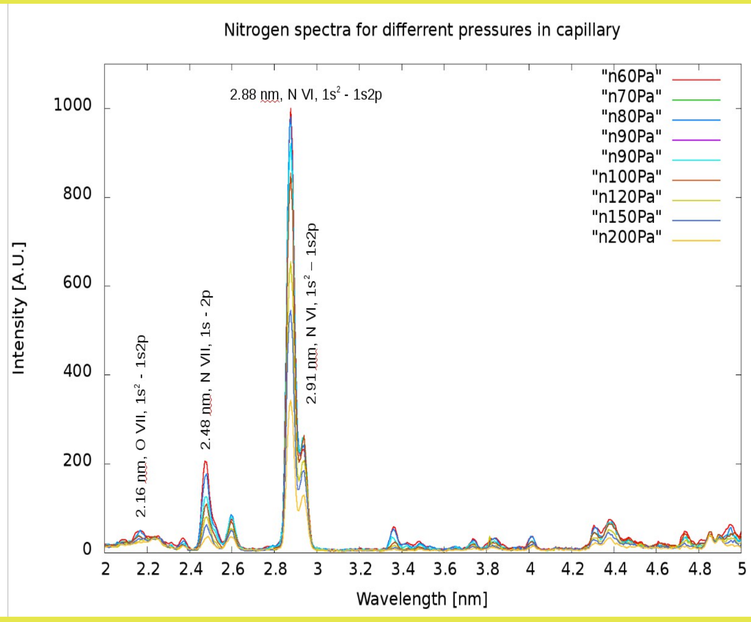

Figure 3 Nitrogen spectra without Ti filter

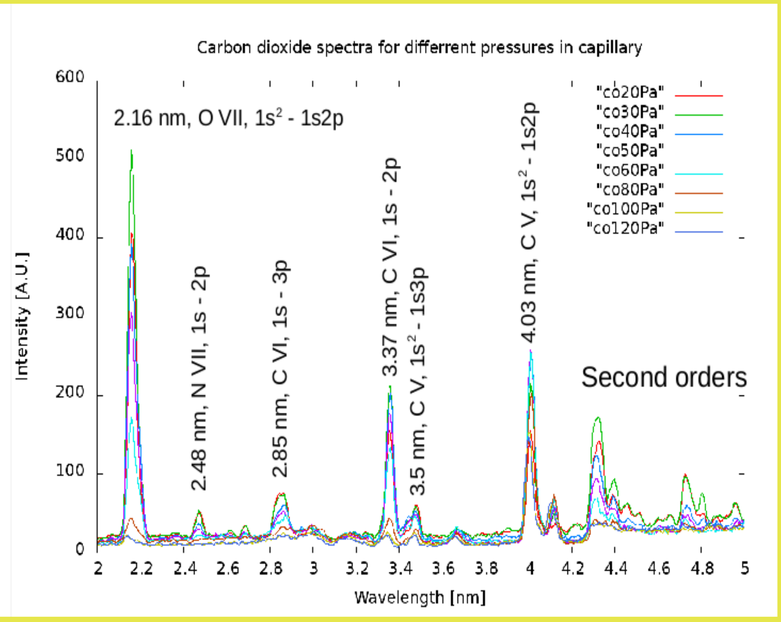

Figure 4 Carbon dioxide spectra without Ti filter

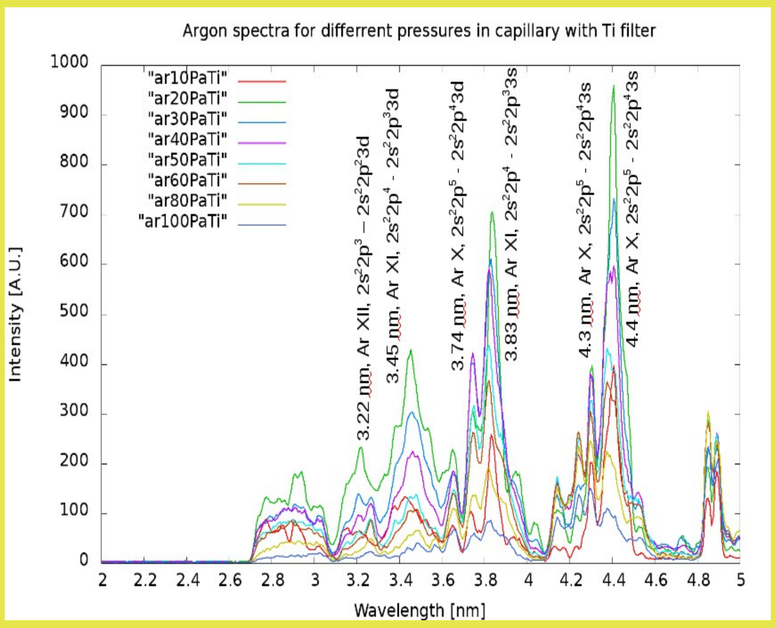

Figure 5 Argon spectra with Ti filter

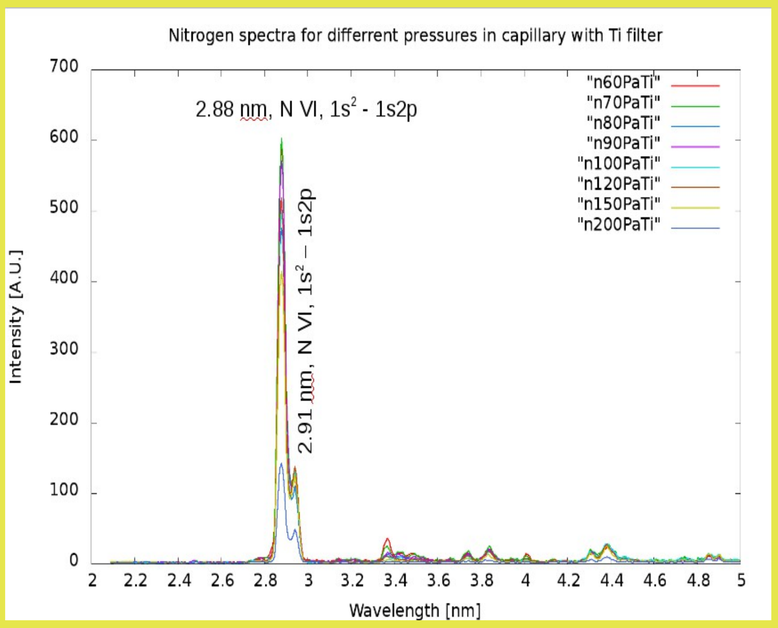

Figure 6 Nitrogen spectra with Ti filter

CONCLUSION

We measured spectra of argon, nitrogen and carbon dioxide as possible source for XUV imaging. Nitrogen is well known as the source with strong emission at 2.88 nm. As other possible sources can be used carbon at 3.37 nm and argon in the region from 3.4 nm to 3.9 nm. It can be seen, that nitrogen has 2x greater maximal energy in water window than carbon dioxide and argon has aproximately 4x greater maximal energy per pulse in water window than nitrogen.

REFERENCES

1. Nevrkla M. et al., Characterization of Capillary Discharge Water-Window Radiation Source, Conference poster, 2012 International Workshop on EUV and Soft X-Ray Sources, S 24
2. A.Chowdhury et al., Optimization of soft x-ray line emission from laser-produced carbon plasma with laser intensity, Pramana – J.Phys, Vol. 61, No. 6, December 2003

ACKNOWLEDGEMENT

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